Reducing Rates of Agrotain® for Seedrow Applications

J. Harapiak, R. Karamanos, N. Flore and T. Stonehouse
Western Cooperative Fertilizers Limited
jharapiak@shaw.ca (403) 281-3132

Introduction

The introduction of direct seeding in the western Canadian prairies has necessitated placing urea N fertilizer with the seed. Plant stand reduction due to seed-placement of high rates of urea N fertilizers is attributed to the toxic effects of ammonia/ammonium. Current guidelines for seed-row placement of nitrogen in general and urea in particular to avert seedling damage are based on seedbed utilization, soil texture (Saskatchewan Agriculture, Food and Rural Revitalization 2001) and seedbed moisture (Western Cooperative Fertilizers Limited 2002). However, crop requirements often exceed these guidelines, which results either in reduction of potential yield through application of lower than recommended N rates or application of fertilizer in a less efficient manner.

An extensive research program was carried out determine the benefit of using urease inhibitor Agrotain® (N-(*n*-butyl)thiophosphoric triamide or NBPT) with seed-placed urea and to develop guidelines for the safe seed-placed application of NBPT-treated urea (Karamanos et al. 2004). The objective of this study was to ascertain whether there is a potential for adjusting the rate of Agrotain® that is used when urea is broadcast when this form of fertilizer is utilized for seedrow placement purposes.

Materials And Methods

Four experiments involving a total of 39 trials were carried out between 1997 and 1999 (Karamanos et al. 2004). In summary, all trials of Experiment 1 were arranged as a split-plot design with N rates (0, 20, 40, 60 and 80 kg N ha^{-1}) as a main plot and four rates of Agrotain® (0, 0.046, 0.093 and 0.14% by weight, representing 33, 66 and 100 % of the recommended rate) as sub-plots. Experiment 2 consisted of seventeen trials with six rates of N (0, 20, 30, 40, 60, 80 kg N ha^{-1} for barley and wheat and 0, 15, 22.5, 30, 45 and 60 kg N ha^{-1} for canola) as main plots and three rates NBPT urease inhibitor (0 and 0.046, and 0.14 % by weight) as sub-plots. Experiment 3 contained twelve trials. Six rates of Agrotain® (0, 0.14, 0.28, 0.42, 0.56 and 0.84 % by weight, representing 25, 50, 75, 100 and 150% of the recommended rate) were applied to one rate of N that was double the recommended for safe seed-placement (30 and 60 kg N ha^{-1} for canola and cereals, respectively) and was compared to an unfertilized control. Phosphorus in all experiments was applied to all treatments in the seed row as triple super phosphate (0-45-0) at a rate of 30 kg P_2O_5 ha^{-1}. Experiment 4 was conducted in 1999 and was similar to Experiment 3 except only three rates of NBPT urease inhibitor were used, namely, 0, 0.28, 0.56 by weight or 0. 50 and 100% of the recommended rate, respectively. A rain gauge was placed at each site, except at Herronton in 1998, and readings were taken from each site 7 days after seeding and at regular intervals, thereafter.

Emergence counts were determined at the 2 to 4 leaf growth stage as the average of two counts, each consisting of two 1-m row lengths, per plot.

Emergence counts from individual trials were subject to ANOVA for a split-plot or a randomized complete block design as required using SYSTAT 8.0 and effects were separated via orthogonal contrasts. The mean over all Agrotain® rates was used for regression analysis to compare the effect of Agrotain® treated versus untreated urea on stand density.

Results And Discussion

The following criteria were established for assessing the impact of Agrotain® treatment on the safety of placing urea with the seed (Karamanos et al. 2004):

1. Trials that received 5-10 mm of precipitation within 48 hours of seeding (or more than 40 mm of precipitation within seven days after seeding) were excluded from the population, since there was no damage from seed-placement of N.
2. A safe N rate was defined as the one that resulted in less than 15% reduction in the stand density of plants and no delay in days to maturity.

Reduction in plant stand density due to N application was observed in 80 % (31 of the 39) of the trials; Agrotain® resulted in a significant improvement of stand density in two out of every three (20 of the 31) trials, where a significant reduction of stand density due to N application was observed. There were no cases where an increase in seedling damage was observed as a result of Agrotain® treatment of urea.

Over the three years of this study with all three crops, seed-placement of urea treated with Agrotain® consistently reduced seedling damage. Reduction in seedling damage has been attributed to an increase in the duration of urea diffusion away from the seedrow as a result of the reduction in urea hydrolysis with application of Agrotain® (Malhi et al 2003); it has been shown to occur with a number of crops, such as barley (Grant and Bailey 1999; Pauly et al. 1996), wheat (Xiaobin et al. 1995; Pauly et al. 1996; Malhi et al. 2003), canola (Pauly et al. 1996; Malhi et al. 2003) and corn (Schlegel 1991). Grant and Bailey (1999) observed that improvement in seed-placed urea safety with Agrotain® was dependent on the environmental conditions occurring after seeding. This was verified in this study; however, increase in stand density as a result of less seedling damage was greater in barley (Figure 1) than wheat (Figure 2) or canola (Figure 3).

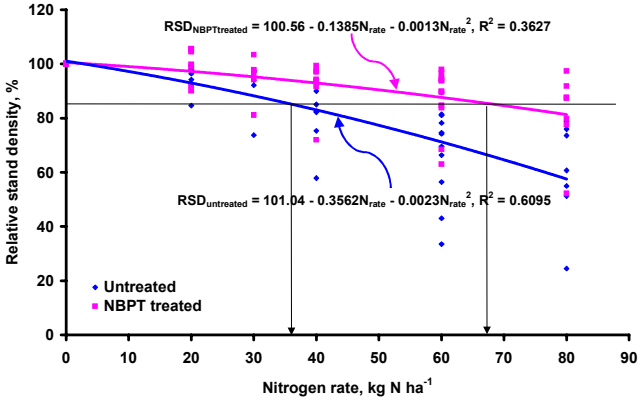

Figure 1. Effect of Agrotain® treatment of urea on the stand density of barley.

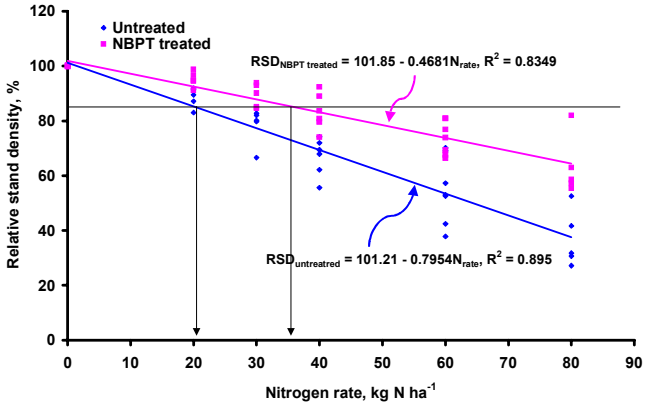

Figure 2. Effect of Agrotain® treatment of urea on the stand density of wheat.

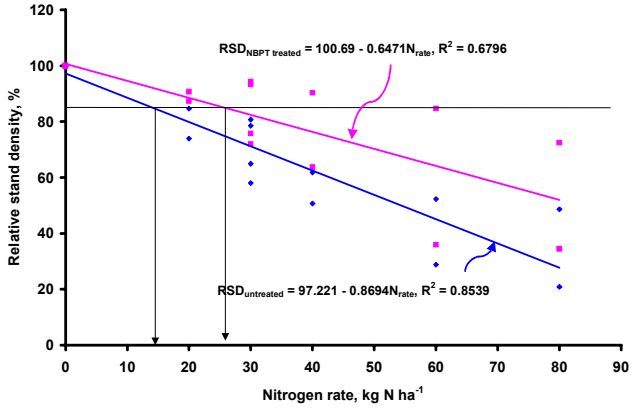

Figure 3. Effect of Agrotain® treatment of urea on the stand density of canola.

Karamanos et al. (2004) found that treating urea with Agrotain® at rates as low as one third of the recommended rate overall produced similar results to those of the recommended rate in all but one trial. However, these authors did not present individual data from their experiments. These data were, therefore, compiled in this paper and are presented in Tables 1 through 5.

Table 1. Impact of N and Agrotain® on plant stand density of cereals in Experiment 1.

	Agrotain rate relative to full rate of 5.2 L tonne^{-1} of urea				
N Rate	0	100%	67%	33%	Mean
0	152	152	152	152	152
20	144	147	148	146	146
40	130	135	137	134	134
60	108	125	125	129	122
80	102	117	116	115	113
Mean	121	131	132	131	

Table 2. Impact of N and Agrotain® on plant stand density of cereals in Experiment 2.

	Agrotain rate relative to full rate of 5.2 L tonne^{-1} of urea				
N Rate	0	100%	67%	33%	Mean
0	200	200	200	200	191
20	193	192	192	181	181
40	185	182	163	174	173
60	170	140	161	162	154
80	117	150	148	138	166
Mean	176	177			

Table 3. Impact of N and Agrotain® on plant stand density of canola in Experiment 2.

	Agrotain rate relative to full rate of 5.2 L tonne^{-1} of urea			
N Rate	0	100%	33%	Mean
0	109	109	109	109
15	93	107	95	98
22.5	86	101	92	93
30	64	92	82	79
45	49	73	63	62
60	41	62	60	55
Mean	74	90	83	

Table 4. Impact of N and Agrotain® on plant stand density and days to maturity (DTM) of cereals in Experiment 3.

N Rate	Relative stand, %	DTM
0 N	192	92.6
Safe N	159	93.1
Elevated N	139	94.1
Elevated N, Agrotain @ 150%	158	93.3
Elevated N, Agrotain @ 100%	155	93.5
Elevated N, Agrotain @ 75%	156	93.4
Elevated N, Agrotain @ 50%	156	93.4
Elevated N, Agrotain @ 25%	155	93.5

Grant and Bailey (1999) observed that seedling damage reduced seedling vigour and delayed maturity in addition to a reduction in stand density. Karamanos et al. (2004) found that maturity in this study was delayed for up to 5.1 d yr^{-1} in barley and 1.8 d yr^{-1} in wheat. Treatment of urea with Agrotain® resulted in an overall reduction in days to maturity (DTM) depending on the rate of N applied in the seedrow. These authors also observed that the higher the rate of seed-row placed N the greater the benefit from treating urea with Agrotain® and that proportionally, a greater benefit was observed with barley compared to wheat, which is not surprising considering the difference in the magnitude of the delay in DTM between these two crops.

Table 5. Impact of N and Agrotain® on plant stand density and days to maturity (DTM) of canola in Experiment 3.

N Rate	Relative stand, %	DTM
0 N	89	125.1
Safe N	79	124.7
Elevated N	66	124.7
Elevated N, Agrotain @ 150%	80	124.4
Elevated N, Agrotain @ 100%	77	124.4
Elevated N, Agrotain @ 75%	78	124.4
Elevated N, Agrotain @ 50%	74	124.4
Elevated N, Agrotain @ 25%	71	124.3

Conclusions

Based on use of Agrotain® test product utilized in these trials, a 66% reduction of the recommended rate for seedrow applications for cereals and a 50% reduction for canola could be warranted. Since the concentration of the active ingredient (i.e. NBPT) in product used in these studies was higher than in the Agrotain that is now commercially available to growers, rates of 2.5 litres per tonne of urea for cereals (excluding hulless barley) and 3.5 litres per tonne of urea for canola, flax & hulless barley are proposed.

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